Strength in numbers

A spectacular result for inflationary cosmology needs independent confirmation.

"Space Ripples Reveal Big Bang's Smoking Gun", ran the headline in the *New York Times*; "Primordial gravitational wave discovery heralds 'whole new era' in physics", said *The Guardian*. Media worldwide picked up on the announcement, on 17 March 2014, of the first direct evidence of cosmic inflation — a period of faster-than-light expansion of the Universe, kicking in just 10^{-36} seconds after the Big Bang. Superlatives abound: "This is huge, as big as it gets", commented cosmologist Marc Kamionkowski; "one of the greatest discoveries in the history of science", said MIT's Max Tegmark.

The excitement is justified. Using a radio telescope in Antarctica, the BICEP2 collaboration has produced a map, over a small region of sky, of the 'B-mode' pattern in the polarization of the cosmic microwave background (pictured below; black lines represent the strength of the polarization and its orientation, red and blue areas indicate clockwise and anticlockwise twisting). The point is that a pattern is present: the primordial density fluctuations that are behind much of the polarization of the cosmic microwave background (CMB) would not paint so pretty a picture; here, rather, are the brushstrokes of primordial gravitational waves from inflation.

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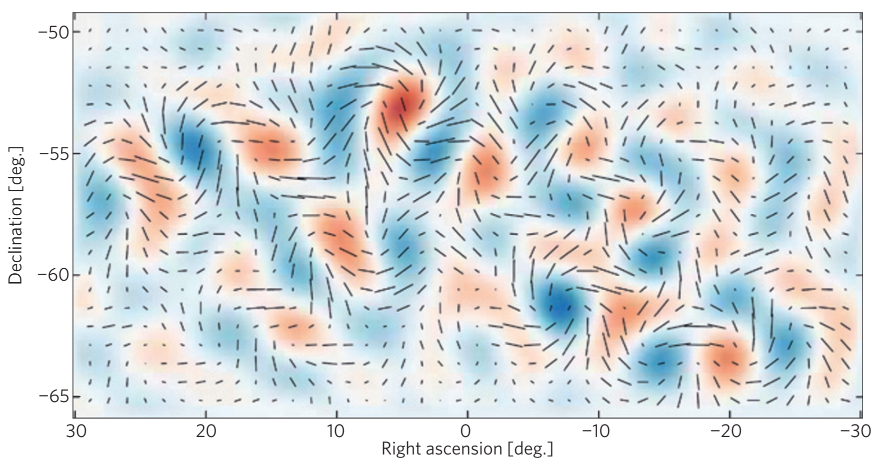
Eyes on the prize: BICEP2 (foreground) and the South Pole Telescope (background).

The B-mode is the curl component of the polarization field, a faint imprint on the CMB captured 380,000 years after the Big Bang. The BICEP2 measurement shows the value of the so-called tensor-to-scalar ratio (connected to the energy scale of inflation) to be $r = 0.20 +0.07/-0.05$. The $r = 0$ scenario — no inflation — is disfavoured at the level of 5.9σ (with foreground dust models subtracted). Tantalizingly, the data set the energy scale of inflation at 10^{16} GeV, just a few orders of magnitude below the Planck scale but coinciding with the likely scale (under certain assumptions) of the unification of the weak, strong and electromagnetic forces.

But... — and there are 'but's. Although these data have been scrutinized within the BICEP2 collaboration, they represent the outcome of a single experiment, and as yet have not been subject to peer-review. Undoubtedly, the BICEP2 team has done all it can to check, check and check again, scrupulously verifying systematic effects through the three phases of data-taking since 2006 and accounting for foreground emission as accurately as possible. At the 17 March press conference, great care was taken to stress that the result must be confirmed in further experiments, and that theme was rightly carried through practically all reports and comments on the finding (including those quoted above): "if it holds", "if this stays true" and "we still need to wait and see".



BICEP2 COLLABORATION

Thankfully, we might not have to wait long. Other observations should follow, for example, from the POLARBEAR experiment mounted on the Huan Tran Telescope and from instruments on the Atacama Cosmology Telescope (ACT) — both of which are in northern Chile. In Antarctica, and standing right alongside BICEP2 (as seen in the photograph above), is the South Pole Telescope: arrays of bolometers attached to the telescope constitute 'SPTpol', a sensitive detector of the CMB polarization. And most eagerly awaited is this year's instalment from the Planck collaboration, who, following last year's spectacular temperature maps of the CMB, should soon be making public the polarization data from their satellite.

Alan Guth, who originally proposed the inflation hypothesis in 1980, has heralded the implications of the BICEP2 result: "If gravity were not quantized, inflation would not produce gravitational waves. So we really are seeing a direct effect caused by the quantization of gravity, and it is the first time we've seen anything like that" (http://go.nature.com/MDFPYg). However, he too cautions that "No experiment should be taken too seriously until there's more than one that can vouch for it." ❐